UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/041,068	11/01/2001	Kazuya Kitamura	56672 (70904)	5240

21874 7590 02/13/2006

EDWARDS & ANGELL, LLP
P.O. BOX 55874
BOSTON, MA 02205

EXAMINER	
HUBER, PAUL W	

ART UNIT	PAPER NUMBER
2653	

DATE MAILED: 02/13/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Interview Summary	Application No.	Applicant(s)	
	10/041,068	KITAMURA ET AL.	
	Examiner	Art Unit	
	Paul Huber	2653	

All participants (applicant, applicant's representative, PTO personnel):

(1) *Paul Huber*. (3)_____.

(2) *William J. Daley*. (4)_____.

Date of Interview: *09 February 2006*.

Type: a)☒ Telephonic b)☐ Video Conference
c)☐ Personal [copy given to: 1)☐ applicant 2)☐ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☒ No.
If Yes, brief description: _____.

Claim(s) discussed: *N/A*.

Identification of prior art discussed: *N/A*.

Agreement with respect to the claims f)☐ was reached. g)☐ was not reached. h)☒ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: *The examiner was informed that an IDS previously filed on January 31, 2002 was not considered. The examiner informed the applicant's representative that no such IDS was on file and that a copy of the IDS should be resubmitted via facimile*.

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN A NON-EXTENDABLE PERIOD OF THE LONGER OF ONE MONTH OR THIRTY DAYS FROM THIS INTERVIEW DATE, OR THE MAILING DATE OF THIS INTERVIEW SUMMARY FORM, WHICHEVER IS LATER, TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

PAUL W. HUBER
PRIMARY EXAMINER

Examiner Note: You must sign this form unless it is an Attachment to a signed Office action.

Examiner's signature, if required

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)
In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

UNITED STATES DEPARTMENT OF COMMERCE
U.S. Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450

APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.

EXAMINER	
ART UNIT	PAPER
	020906

DATE MAILED:

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner for Patents

The Information Disclosure Statement filed February 9, 2006 (originally filed January 31, 2002) was considered. Please find enclosed a copy of the initialed PTO-1449.

Paul Huber
Primary Examiner
Art Unit: 2653

Attorney Docket No. 56,672 (70904)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANTS	K. Kitamura, et al.	EXAMINER:	Huber, Paul W.
U.S.S.N.:	10/041,068	GROUP:	2653
FILED:	November 1, 2001	Conf. No.	5240
FOR:	AN OPTICAL PICKUP FOR OPTICALLY READING/ WRITING DATA INCLUDING CONVERGENT AND ABERRATION CORRECTION OPTICAL SYSTEMS (As-Amended)		

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF FACSIMILE TRANSMISSION

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted by facsimile to (703) 746-5973 at the U.S. Patent and Trademark Office on December 16, 2004.

By: _____
Safiya Jarvis

LETTER TO EXAMINER AFTER ALLOWANCE

Sir:

A Notice of Allowance and Issue Fee Due was mailed December 8, 2004. The within Letter to the Examiner is being filed prior to payment of the issue fee.

An Information Disclosure Statement dated January 31, 2002, was submitted previously, which Applicants also received confirmation of its receipt at the USPTO.

Applicants contacted the Examiner today since the initialed PTO-1449 for this IDS has not been received by Applicants.

Pursuant to the telephone conference with the Examiner of this date, Applicants are enclosing herewith the following and request entry of the IDS and related enclosures into the record of the subject application:

1. A copy of the return postcard with a USPTO mailroom date stamp acknowledging receipt of the IDS.
2. A copy of the Information Disclosure Statement dated January 31, 2002.
3. A copy of the PTO-1449 attached thereto.
4. A copy of the English abstracts and partial translations submitted for the identified Japanese patent documents.

There is no fee required for the submission of the within Letter. However, if for any reason a fee is required for consideration of the within Letter or any of the alternative pleadings, a fee paid is inadequate or credit is owed for any excess fee paid, you are hereby authorized and requested to charge Deposit Account No. **04-1105**.

If the Examiner requires any further information or requires any further clarification regarding the above, then Applicants respectfully request that he call the undersigned collect and the below listed number.

Respectfully submitted,
Edwards & Angell, LLP

Date: December 16, 2004

By: William J Daley Jr

William J. Daley, Jr.
(Reg. No. 35,487)
P.O. Box 55874
Boston, MA 02205
(617) 439- 4444

Customer No. 21,874

DEC/WJD

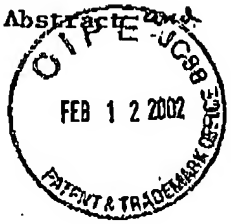
56672 (0904)

Mailing Date:	January 31, 2002	Attorney/Sec:	WJD/clm
Client:	70904	Docket No.:	56672
Investors:	KITAMURA et al		
Serial No.:	10/041,068	Patent No.:	
Filing Date:	November 01, 2001	Grant Date:	

"OPTICAL PICKUP"

The dating stamp of the Patent and Trademark Office hereon will be taken as the date of filing of:

1. PTO FORM 1449, 1 page, 4 references
2. Information Disclosure Statement, 3 pages
3. Copies of 4 Japanese References with Abstracts and partial translations
4. Certificate of Service.



Due Date: February 1, 2002

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	KITAMURA et al		
U.S.S.N.:	10/041,068		
FILED:	November 1, 2001	Art Unit:	Unassigned
FOR:	OPTICAL PICKUP	Examiner:	Unassigned

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail, Postage prepaid, in an envelope addressed to Commissioner for Patents, Washington, D.C. 20231 on January 31, 2002.

By: _____
Fatima H. DeArruda

INFORMATION DISCLOSURE STATEMENT (SUBMISSION AFTER FILING OF AN APPLICATION BUT BEFORE FINAL REJECTION OR NOTICE OF ALLOWANCE)

Commissioner for Patents and Trademarks
Washington, D.C. 20231

Date January 31, 2002

Sir:

Pursuant to 37 C.F.R. §§ 1.97 and 1.98, applicant(s) hereby submit(s) an Information Disclosure Statement for consideration by the Examiner.

I. LIST OF PATENTS, PUBLICATIONS OR OTHER INFORMATION

The patents, publications or other information submitted for consideration by the Office are listed on PTO-1449, attached hereto.

II. COPIES

a. ☒ Submitted herewith is a legible copy of (i) each U.S and foreign patent; (ii) each publication or that portion which caused it to be listed; and (iii) all other information or that portion which caused it to be listed.

III. CONCISE EXPLANATION OF THE RELEVANCE
(check at least one box)

a. ☐ Except as may be indicated below in (b), all of the patents, publications or other information are in the English language or were cited in an English

language Search Report, a copy of which is attached hereto (concise explanation not required).

b. ☒ A concise explanation of the relevance of all patents, publications or other information listed that is not in the English language is as follows: Abstracts and partial translation for references BA-BD

c. ☐ The following additional information is provided for the Examiner's consideration:

FEES

IV. THIS IDS IS BEING FILED UNDER 37 C.F.R. § 1.97(b)
(check one box)

a. ☒ within three months of the filing date of a national application (37 C.F.R. § 1.97(b) (1)). No fee or certification is required.

b. ☐ within three months of the date of entry of the national stage as set forth in §1.491 in an international application (37 C.F.R. § 1.97(b) (2)). No fee or certification is required.

c. ☐ before the mailing date of a first Action on the merits (37 C.F.R. § 1.97(b) (3)). No fee or certification is required. In the event that a first Office Action on the merits has been issued, please consider this IDS under 37 C.F.R. § 1.97(c) and see the certification under 37 C.F.R. § 1.97(c)below, or, if no certification has been made, charge our deposit account a fee in the amount of $240.00 as required by 37 C.F.R. § 1.17(p).

V. THIS IDS IS BEING FILED UNDER 37 C.F.R. § 1.97(c):
(check one box)

a ☒ before the mailing date of a Final Office Action under 37 C.F.R. § 1.113 (See 37 C.F.R. § 1.97(c) (1)) or before the mailing date of a Notice of Allowance under 37 C.F.R. § 1.311 (See 37 C.F.R. § 1.97(c) (2)).

b. ☐ No certification; therefore, a fee in the amount of $240.00_____ is required by 37 C.F.R. . § 1.17(p).

or

c. ☐ See the certification below. No fee is required.

VI. CERTIFICATION UNDER 37 C.F.R. § 1.97(e) (check only one box)

The undersigned hereby certifies that

a. ☐ each item of information contained in the IDS was cited in a communication from a foreign Patent Office in a counterpart foreign application not more than three months prior to the filing of this IDS; or

b. ☐ no item of information contained in the IDS was cited in a communication from a foreign Patent Office in a counterpart foreign application or, to the best of my knowledge after making reasonable inquiry, was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this statement.

c. ☒ Some of the items of information were cited in a communication from a foreign Patent Office. As to this information, the undersigned certifies that each item of information contained in the IDS was cited in a communication from a foreign Patent Office in a counterpart foreign application not more than three months prior to the filing of this IDS. As to the remaining information, the undersigned hereby certifies that no item of this remaining information contained in the IDS was cited in a communication from a foreign Patent Office in a counterpart foreign application or, to the best of my knowledge after making reasonable inquiry, was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this statement.

☐ Please charge Deposit Account No. 04-1105 in the amount of $240.00 for the above-indicated fee. A triplicate copy of this paper is attached.

☒ No fee is required.

If the Examiner has any questions concerning this IDS, he/she is requested to contact the undersigned. If it is determined that this IDS has been filed under the wrong rule, the PTO is requested to consider this IDS under the proper rule (with a petition, if necessary) and charge the appropriate fee to Deposit Account No. 04-1105.

Respectfully submitted,

Date: January 31, 2002

William J. Daley

William J. Daley, Jr. (Reg. No. 35,487)
DIKE, BRONSTEIN, ROBERTS & CUSHMAN
Intellectual Property Practice Group
EDWARDS & ANGELL, LLP
P.O. Box 9169
Boston, MA 02209
Tel: (617) 439-4444

(11)Publication number : 10-123410
(43)Date of publication of application : 15.05.1998
10-123410

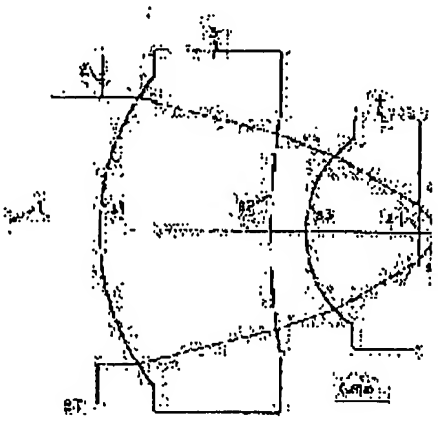
(51)Int.Cl. G02B 13/00
G02B 3/02
G02B 13/18
G11B 7/135

(21)Application number : 08-282750
(22)Date of filing : 24.10.1996

(71)Applicant : SONY CORP
(72)Inventor : YAMAMOTO KENJI
ICHIMURA ISAO
MAEDA FUMISADA
WATANABE TOSHIO
OSATO KIYOSHI

(54) OBJECTIVE LENS AND OPTICAL PICKUP DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an objective lens capable of obtaining sufficiently high numerical aperture(NA), sufficiently correcting color aberration, making light in weight and facilitating manufacture by using low dispersion glass material whose Abbe number is specified for glass material constituting two lenses as a color aberration countermeasure for two lenses of two groups.
SOLUTION: The objective lens possesses the constitution of two groups being two lenses formed of the glass material whose Adde number at a (b) line is □40, and at least one surface is made as an aspherical surface, and the numerical aperture is made as □7.0. Thus, the objective lens is constituted of a first lens 3 arranged on the side of an object (the side of a light source) and a second lens 4 arranged on the side of an image(the side of an optical recording medium). A plane parallel plate 5 equivalent to the transparent substrate of the optical recording medium is arranged on the side of the image of the objective lens. In this case, the low dispersion glass material is used for the glass material so as to suppress the color aberration.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Japanese Laid-Open Patent Publication No. 10-123410/1998

(Tokukaihei 10-123410) (Published on May 15, 1998)

(A) Relevance to Claims

The following is a translation of passages related to all the claims of the present invention.

(B) Translation of Relevant Passages

[Claims]

[Claim 1] An objective lens, comprising two lenses forming two groups, each lens being made of a glass material having an Abbe constant of not less than 40 at d line, said objective lens having at least one aspherical surface and a numerical aperture of not less than 0.7.

[Claim 2] The objective lens as defined in claim 1, wherein the glass materials forming the two lenses have an Abbe constant of not less than 60 at d line and said objective lens has a numerical aperture of not less than 0.8.

[Claim 4] The objective lens as defined in claim 1,

satisfying $1.0 \leq BW < 4.5$ and $0.05 \leq WD$ and further satisfying $WD \leq 0.25676\ BW + 0.039189$ when $0.7 \leq NA < 0.8$, $WD \leq 0.14054\ BW - 0.064865$ when $0.8 \leq NA < 0.9$, and $WD \leq 0.096429\ BW - 0.244640$ when $0.9 \leq NA$, where BW is a diameter of an incident light flux, WD is a working distance, and NA is a numerical aperture.

[Claim 6] The objective lens as defined in claim 1, positioned over a signal recording surface of an optical storage medium, subjected to aberration correction corresponding to a thickness T of a transparent substrate supporting the signal recording surface, and satisfying $T \leq 0.32$ mm when $0.7 \leq NA < 0.8$, $T \leq 0.20$ mm when $0.8 \leq NA < 0.9$, and $T \leq 0.11$ mm when $0.9 \leq NA$.

[Claim 7] An optical pickup, comprising a light source and an objective lens for focusing a light flux projected by the light source onto a signal recording surface of an optical storage medium, wherein the objective lens comprises two lenses forming two groups, each lens being made of a glass material having an Abbe constant of not less than 40 at d line, and the objective lens has at least one aspherical surface and a numerical aperture of not less than 0.7.

[Claim 8] The optical pickup as defined in claim 7,

wherein the glass materials forming the two lenses have an Abbe constant of not less than 60 at d line and said objective lens has a numerical aperture of not less than 0.8.

[0008] Objective lenses with a high NA has a problem of color aberration caused by variations in wavelength of a semiconductor laser (longitudinal mode hop due to changes in ambient temperature). ...

[0009] However, objective lenses with an NA as high as 0.7 or more, when made in high-dispersion glass material, cause large color aberration and intolerable defocus on the signal recording surface of an optical disk. Accordingly, relatively low-dispersion glass material must be used to suppress color aberration.

[0010] ... Current aspherical fabrication technologies are short of fabricating a metal mold with a diamond tool if the aspherical contact surface and a plane vertical to the optical axis make an angle θ exceeding 50° (it is reported that in practice, a good lens was obtained with the angle θ up to about 55°).

(11)Publication number : 2000-131603
(43)Date of publication of application : 12.05.2000
2000-131603

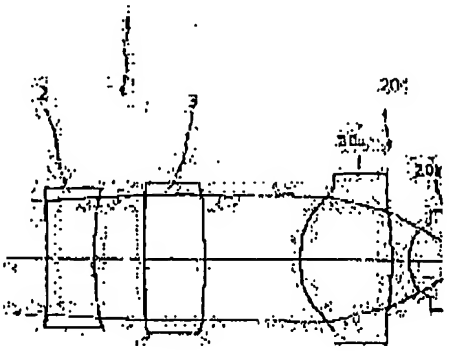
(51)Int.Cl. G02B 13/00

(21)Application number : 10-301480
(22)Date of filing : 22.10.1998

(71)Applicant : SONY CORP
(72)Inventor : YAMAMOTO KENJI
OSATO KIYOSHI

(54) OPTICAL HEAD AND RECORDING AND REPRODUCING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To correct the spherical aberrations by the production errors of optical recording media and lenses, to sufficiently correct chromatic aberrations even when a short wavelength semiconductor laser is used and to also correct the spherical aberrations which occur when using the same optical system for light of different wavelengths by providing the above head with an objective lens having a high numerical aperture of □0.8.
SOLUTION: The optical head has a light source, the objective lens 20 which is composed of □2 elements of the lenses and has the numerical aperture of □0.8 and an aberration correction lens group 1 which is arranged between the light source and the objective lens 20 and is composed of two groups; a positive lens group 3 and a negative lens group 2. The aberration correction lens group 1 corrects the spherical aberrations which occur on the respective optical surfaces of the optical system by the spacing between the positive lens group 3 and the negative lens group 2 which is varied in an optical axis direction.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Japanese Laid-Open Patent Publication No. 2000-131603 (Tokukaihei 2000-131603) (Published on May 12, 2000)

(A) Relevance to Claims

The following is a translation of passages related to all the claims of the present invention.

(B) Translation of Relevant Passages

[Claims]

[Claim 1] An optical head, comprising: a light source; an objective lens constituted by two or more lenses and having a numerical aperture of not less than 0.80; and an aberration correction lens system constituted by a positive lens system and a negative lens system and positioned between the light source and the objective lens, wherein the aberration correction lens system corrects spherical aberration which develops at each optical surface of the optical system by varying the distance between the positive lens system and the negative lens system constituting the aberration correction lens system in a direction of an optical axis.

[Claim 2] The optical head as set forth in claim 1,

further comprising an actuator for varying and thus adjusting the distance between the positive lens system and the negative lens system constituting the aberration correction lens system in a direction of an optical axis.

[Claim 3] The optical head as set forth in claim 1, wherein the objective lens is constituted by two or more lenses forming two groups.

[Claim 4] The optical head as set forth in claim 3, further comprising an actuator for varying and thus adjusting the distance between the positive lens system and the negative lens system constituting the aberration correction lens system in a direction of an optical axis.

[Claim 5] The optical head as set forth in claim 1, wherein the light source is a semiconductor laser having a light-emitting wavelength of not more than 440 nm, the objective lens is composed of glass material having an Abbe constant of not more than 95.0 at d line and a focal length of not less than 1.4 mm, and the aberration correction lens system is constituted by a positive lens having an Abbe constant of not less than 55 and a negative lens having an Abbe constant of not more than 35.

[Claim 6] The optical head as set forth in claim 5, further comprising an actuator for varying and thus

adjusting the distance between the positive lens system and the negative lens system constituting the aberration correction lens system in a direction of an optical axis.

[Claim 7] The optical head as set forth in claim 5, correcting spherical aberration which develops at each optical surface of the optical system in conjunction with an aberration correction lens system by varying the distance between the lens systems constituting the objective lens in a direction of an optical axis.

[Claim 8] The optical head as set forth in claim 7, further comprising an actuator for varying and thus adjusting the distance between the positive lens system and the negative lens system constituting the aberration correction lens system and the distance between the lens systems constituting the objective lens in a direction of an optical axis.

[Claim 9] A recording/reproducing device, comprising: a light source; an objective lens constituted by two or more lenses and having a numerical aperture of not less than 0.80; an aberration correction lens system constituted by a positive lens system and a negative lens system and positioned between the light source and the objective lens; an actuator for varying and thus adjusting a distance between the positive lens system and

the negative lens system constituting the aberration correction lens system in a direction of an optical axis; and an optical detecting device for detecting reflection of a light flux by the optical storage medium, the light flux being projected by the light source and focused onto the optical storage medium by the objective lens, wherein the aberration correction lens system corrects spherical aberration which develops at each optical surface of the optical system by the distance between the positive lens system and the negative lens system constituting the aberration correction lens system in a direction of an optical axis.

[Claim 10] The recording/reproducing device as set forth in claim 9, wherein the objective lens is constituted by two or more lenses.

[Claim 11] The recording/reproducing device as set forth in claim 9, wherein the light source is a semiconductor laser having a light-emitting wavelength of not more than 440 nm, the objective lens is composed of glass material having an Abbe constant of not more than 95.0 at d line and a focal length of not less than 1.4 mm, and the aberration correction lens system is constituted by a positive lens having an Abbe constant of not less than 55 and a negative lens having an Abbe constant of not more

than 35.

[Claim 12] The recording/reproducing device as set forth in claim 11, correcting spherical aberration which develops at each optical surface of the optical system in conjunction with an aberration correction lens system by varying the distance between the lens systems constituting the objective lens in a direction of an optical axis, wherein the actuator varies and thus adjusts not only the distance between the positive lens system and the negative lens system constituting the aberration correction lens system, but also the distance between the lens systems constituting the objective lens, in a direction of an optical axis.

[0005]

[Problems to be Solved by the Invention] However, the aforementioned optical head develops various problems if the numerical aperture of its objective lens is increased and the wavelength of the light source is cut shorter. Those problems are optical spherical aberration and color aberration.

[0006] Spherical aberration develops for various reasons including manufacturing errors in thickness of, principally, a lens, or a transparent substrate for an

optical storage medium and a assembly errors in the distance between lens systems when the objective lens is constituted by multiple lenses. Spherical aberration also results from the use of an optical system with different wavelengths. For example, with respect to the errors in thickness of the transparent substrate in an optical storage medium, 3-dimensional spherical aberration caused by thickness errors of the transparent substrate in a "CD"specifications disk and "DVD" recording disk develops in proportion to the fourth power of the numerical aperture (NA) of the objective lens as can be seen from equation 1 below; the greater the numerical aperture of the objective lens, the greater the adverse effect of the thickness errors.

[0021] The aberration correction lens system is constituted by a 2-system lens system, one positive and the other negative, separated from each other by a distance. These positive and negative lens systems are only required to be positive and negative respectively in power and may be constituted by a single lens or multiple lenses.

[0068] A phase-transformation optical disk 11 on which data is written or read by the optical head 10 includes:

a signal recording layer in which an information signal is recorded by phase transformation formed on a transparent substrate 12 having a thickness t2 of, for example, 1.2 mm or 0.6 mm; and a protection layer 13 having a thickness t3 of, for example 0.1 mm formed on the signal recording layer. The phase-transformation optical disk 11 is adapted so that a signal is written and read in the signal recording layer as the disk 11 receives incident light not on the side of the transparent substrate 12, but on the side of the protection layer 13 which is far thinner than the transparent substrate 12. Note however that the optical head 10 in accordance with the present invention is also applicable to optical storage media which receives incident light on the side of the transparent substrate 12 for recording and reproduction.

(11)Publication number : 10-142494
(43)Date of publication of application : 29.05.1998

(51)Int.Cl. G02B 13/00
G11B 7/135

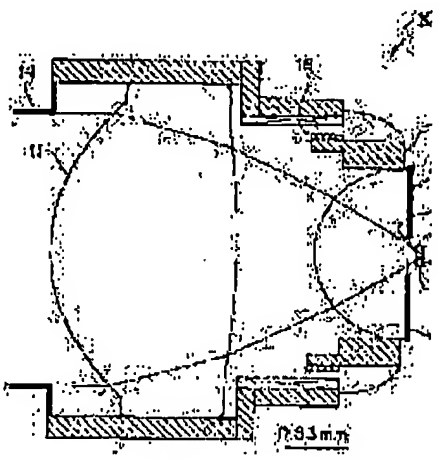
10-142494

(21)Application number : 08-303238
(22)Date of filing : 14.11.1996

(71)Applicant : SONY CORP
(72)Inventor : YAMAMOTO KENJI
ICHIMURA ISAO
MAEDA FUMISADA
WATANABE TOSHIO
OSATO KIYOSHI

(54) OBJECTIVE LENS DEVICE AND RECORDING AND REPRODUCING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To make an objective lens device and a recording and reproducing device correspond to an optical recording medium different in base plate thickness and opening degree.
SOLUTION: In this objective lens device 10, a distance between a 1st lens 11 and a 2nd lens 12 is adjusted by a 2nd lens driving mechanism 16 to be made correspond to the base plate thickness of an optical disk 20. By providing a 2nd diaphragm 15 on the surface 12a of the 2nd lens 12 proximately opposed to the optical disk 20 in addition to a 1st diaphragm 14, the device 10 is made correspond to the opening degree of the optical disk 20.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Japanese Laid-Open Patent Publication No. 10-142494/1998

(Tokukaihei 10-142494) (Published on May 29, 1998)

(A) Relevance to Claims

The following is a translation of passages related to all the claims of the present invention.

(B) Translation of Relevant Passages

[0009]

[Problems to be Solved by the Invention] Different objective lens devices were made for optical storage media of different specifications. In other words, different lenses or diffractive holograms were prepared suitably for optical storage media having different substrate thicknesses and NAs.

[0010] If different lenses are used depending on the optical storage media, the lens must be replaced every time the medium is changed. Further, multiple lenses are difficult to accommodate in a compact objective lens device. Meanwhile, diffractive holograms are expensive and technically difficult to use.

[0011] Accordingly, in view of the above situations, the

present invention has an object to present an objective lens device which is operable with optical storage media of different substrate thickness and NAs. Another object of the present invention is to present a recording/reproducing device which incorporates the aforementioned objective lens device in accordance with the present invention and which is capable of writing and reading information signal on optical storage media of different specifications in a satisfactory manner.

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 09-311271
(43)Date of publication of application : 02.12.1997

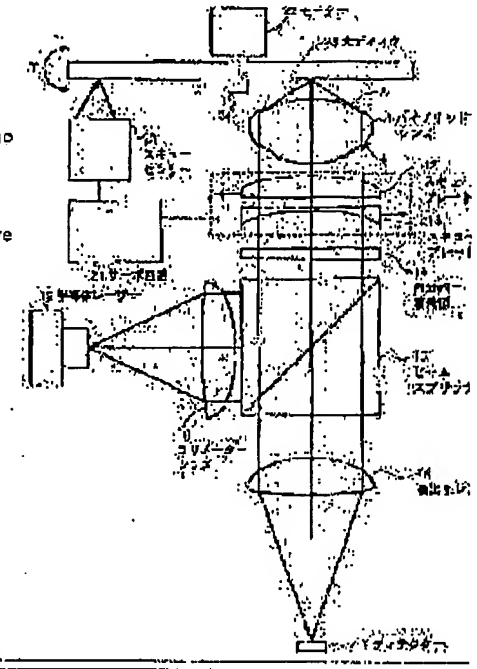
(51)Int.Cl. G02B 13/00
G02B 5/18
G02B 13/18
G11B 7/135

(21)Application number : 08-125160
(22)Date of filing : 20.05.1996

(71)Applicant : SONY CORP
(72)Inventor : SUGANUMA HIROSHI

(54) OBJECTIVE LENS AND OPTICAL PICKUP DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To correct chromatic aberration by making numerical aperture equal to or above a specified value by respectively providing phase type diffraction type lenses on both surfaces of a single lens whose first and second surfaces are aspherical and satisfying a specified condition.
SOLUTION: The phase type diffraction type lenses 4 and 5 are added to both surfaces 2 and 3 of the single lens 1 whose both surfaces are the aspherical surfaces and which is constituted of glass material having high refractive index and high dispersion, so that an objective lens having the high numerical aperture of □0.7 is realized. In the case that center wavelength is set as λ2 and wavelength is used from shortest wavelength λ1 to longest wavelength λ3, and when the refractive indexes of the glass material forming the lenses 1, 4 and 5 at each wavelength λ1, λ2 or λ3 are respectively set as n1-n3, and the Abbe's number V of the glass material at this area is set as V=(n2-1)/(n1-n3), and the Abbe's number VHOE of the lenes 4 and 5 is set as VHOE=λ2/(λ1-λ3), the expression of (1+(VHOE/V).(n2-1)>0.572 is valid.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Japanese Laid-Open Patent Publication No. 9-311271/1997

(Tokukaihei 9-311271) (Published on December 2, 1997)

(A) Relevance to Claims

The following is a translation of passages related to all the claims of the present invention.

(B) Translation of Relevant Passages

[Claims]

[Claim 1] An objective lens which is a single lens whose first and second surfaces are both aspherical, said objective lens having a phase-type diffractive lens on each of the surfaces and satisfying

$$(1 + (V_{HOE} / V)) \cdot (n_2 - 1) > 0.572 \quad \text{... Eq. 1}$$

where λ_1, λ_2, and λ_3 are the shortest, central, and longest wavelengths respectively, n_1, n_2, and n_3 are refractive indices of a glass material forming said lens at the wavelengths λ_1, λ_2, and λ_3 respectively, V is an Abbe constant of the glass material in this range and given by $V = (n_2 - 1) / (n_1 - n_3)$, V_{HOE} is an Abbe constant V_{HOE} of

the phase-type diffractive lens and given by $V_{HOE} = \lambda_2 / (\lambda_1 - \lambda_3)$,

said objective lens being subjected to color aberration correction and having a numerical aperture of not less than 0.7.

[Claim 2] The objective lens as set forth in claim 1, having color aberration thereof overcorrected by a phase-type diffractive lens so as to have short focal lengths for short wavelengths.

[Claim 3] The objective lens as set forth in claim 1, wherein a phase-type diffractive lens has an aspherical phase term, and the phase-type diffractive lens has the least pitch between the center and the periphery of the lens.

[Claim 4] The objective lens as set forth in claim 1, wherein a phase-type diffractive lens has grooves each having such a depth to produce an i-time difference in optical path to a wavelength, where i is an integer not more than 10.

[Claim 6] The objective lens as set forth in claim 1, combined with a hemispheric lens to form a solid, liquid immersion-type objective lens.

[Claim 7] An optical pickup, comprising: a light source; an objective lens for focusing a light flux projected by

the light source onto a signal recording surface of an optical storage medium; and an optical detection means for detecting reflection of the light flux from the optical storage medium, wherein said objective lens is a single lens whose first and second surfaces are both aspherical, has a phase-type diffractive lens on each of the surfaces, and satisfies

$$(1 + (V_{HOE} / V)) \cdot (n_2 - 1) > 0.572 \quad \ldots \text{ Eq. 1}$$

where λ_1, λ_2, and λ_3 are the shortest, central, and longest wavelengths respectively, n_1, n_2, and n_3 are refractive indices of a glass material forming said lens at the wavelengths λ_1, λ_2, and λ_3 respectively, V is an Abbe constant of the glass material in this range and given by $V = (n_2 - 1) / (n_1 - n_3)$, V_{HOE} is an Abbe constant V_{HOE} of the phase-type diffractive lens and given by $V_{HOE} = \lambda_2 / (\lambda_1 - \lambda_3)$, and said objective lens is subjected to color aberration correction and has a numerical aperture of not less than 0.7.

[Claim 8] The optical pickup as set forth in claim 7, including a skew servo mechanism for correcting coma aberration caused by an optical axis of an objective lens and a signal recording surface of an optical storage

medium forming an angle not equal to 90°.

[Claim 9] The optical pickup as set forth in claim 7, wherein an optical storage medium is used such that a substrate composed of transparent material composing the optical storage medium has a thickness of not more than 0.6 mm and a light flux is focused onto a signal recording surface through the substrate.

[0045] The present invention has an objective to realize an objective lens having a numerical aperture of not less than 0.7 and having color aberration being corrected as an double-aspherical-face single lens combined integrally with a diffractive lens.

[0057] ... the inventors have found that an objective lens can be made with a numerical aperture as high as 0.7 or more, by attaching a phase-type diffractive lens 4, 5 on each of the surfaces 2, 3 of a single lens 1, composed of high refractive index, high dispersion glass material, whose surfaces are aspherical. ...

[0058] The formation of diffractive lenses on the surfaces of the refractive lens imparts an increased power and a higher numerical aperture (NA) to the refractive lens, without a need to change the curvature

of the surfaces of the refractive lens or the glass material composing the refractive lens.

[0063] Further, a hybrid refractive, diffractive objective lens in accordance with the present invention is capable of correcting spherical aberration and coma aberration to a relatively high order because of the versatility in design with a diffractive lens. Generally, the coma aberration, etc. caused by decentration is a function of a spherical aberration and a coma aberration of a lower order. Restraining the low-order aberration naturally reduces the coma aberration caused by the decentration. Put it differently, a lens can be designed so that they can cancel each other, by optimizing the balance of their development. As a result, the hybrid refractive, diffractive objective lens has greater tolerance to decentration.

[0064] Large color aberration of diffractive lenses presents a problem. Integrating refractive lens with a diffractive lens (making a hybrid lens) causes great color aberration if the diffractive lens and the refractive lens has a power ratio that substantially satisfies decoloring conditions. The power ratio of the lenses is determined by the dispersion of the glass material composing the refractive lens as mentioned

earlier. The greater the dispersion of the glass material, the greater the ratio of the power of the diffractive lens to that of the refractive lens must be. In other words, the diffractive lens can have greater power. Supposing that the power ratio of the lenses substantially satisfy decoloring conditions, color aberration can be corrected by the combination of a diffractive, convex lens to a refractive, convex lens. Therefore, the greater dispersion the glass material has, the greater the resultant power grows with the diffractive lens while correcting the color aberration. Incidentally, the diffractive lens may have a further increased power beyond the decoloring conditions so that the numerical aperture (NA) can be further increased by overcorrection, as long as the color aberration poses no problems in practical use. When this is the case, the shorter the wavelength, the shorter the focal length.

[0109] Two solutions are conceivable to solve the coma aberration caused by an inclination of the optical disk. A first solution an active skew correction. ...

[0110] The principles of the skew correction mentioned here are, for example, as follows. As shown in Figure 23, The aberration is corrected by disposing two compensation

optical elements (skew plate (convex) 12 and skew plate (concave) 13) in an optical system having coma aberration and moving them in opposite direction to develop coma aberration of opposite sign. In the optical system, the light flux projected by a semiconductor laser 19 is collimated by a collimator lens 18, reflected by the parallel light flux, and passed through a quarter wavelength plate 14 and the two compensation optical elements 13, 12, before entering the objective lens (hybrid lens) 1. The objective lens 1 focuses the incident light flux onto a signal recording layer of an optical disk 23 which is supported at its center by a drive axis 24 of a spindle motor 22 and rotated by the spindle motor 22. The light flux is reflected by a signal recording layer of the optical disk 23 and guided back to the beam splitter 15 via the objective lens 1, the compensation optical elements 12, 13, and the quarter wavelength plate 14. The light flux reflected by the signal recording layer of the optical disk 23 is passed through the beam splitter 15 and then a detecting lens 16 before being received by a detector (optical detecting unit) 17. The skew plates 12, 13 are moved in a direction perpendicular to the optical axis of the optical system using a servo circuit 21 based on a result of the

detection by a skew sensor 20 which detects the skew of the optical disk 23 to the optical axis of the objective lens 1. The skew sensor 20 is constituted, for example, by: a light-emitting element, such as a light-emitting diode, for projecting a light flux onto the optical disk 23; and an optical detecting device for detecting reflection of the light flux, and detects the amount of inclination in a radial direction of the optical disk 23 as indicated by an arrow in the Figure 23.

...

[0112] Another solution is to thin down the disk substrate. The thinner the disk substrate, the less the coma aberration of the disk substrate develops due to skew. These solutions, when combined, can realize an optical pickup using an objective lens with a high numerical aperture (NA).